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Bone mineral density in comparison to the anthropometric parameters and level of gross motor function in children with cerebral palsy

Mineralna koštana gustina u poređenju sa antropometrijskim parametrima i stepenom oštećenja grube motoričke funkcije kod dece sa cerebralnom paralizom

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Abstract

Background/Aim. Children with cerebral palsy (CP) grow at a slower rate relative to their peers. Their body height, body weight and bone mineral density are significantly below those measured for healthy children of corresponding age. The aim of this work was to estimate bone mineral density in relation to the anthropometric parameters and the level of gross motor function in the children with cerebral palsy. **Methods.** This cross-sectional pilot study included 23 children with CP, aged 6 to 17 years, in whom the gross motor function level was estimated according to the Gross motor function classification system- expanded and revised (GMFCS-E&R), while the anthropometric parameters were established in relation to the developmental charts for healthy children as well as those pertaining to children with CP. Bone mineral density was measured by dual energy X-ray absorptiometry and the findings were interpreted in accordance with the International Society for Clinical Densitometry Official Positions of Adults & Pediatrics. Mean values with interquartile deviations, along with frequencies and percentages were the descriptive statistical measures employed in the analyses. Differences between groups were ascertained through the Kruskal-Wallis test. **Results.** Our sample of 23 children comprised of 56.5% boys and 43.5% girls, aged 13.00 ± 3.56 years, of whom 3/4 had a severe form of gross motor dysfunction (GMFCS-E&R levels IV and V). All subjects had lower bone density in both regions of interest [spinal Z-score -1.60 ± 1.40 standard devation (SD); hip Z-score -2.00 ± 3.00 SD], as well as lower anthropometric parameters [height Z-score -2.74 ± 4.28; body weight Z-score -3.22 ± 6.96; body mass index (BMI) Z-score -2.64 ± 6.03]. In the observed sample, bone mineral density in the spine ($p < 0.01$) and the hip ($p < 0.05$) was reduced in all subjects, and all children had a lower body weight ($p < 0.01$) and the BMI ($p < 0.01$), but not body height, in relation to the existing developmental charts for the CP children adopted from the US. Children with the CP Level IV on the GMFCS-E&R had a significantly lower bone density (spinal Z-score -1.90 SD; hip Z-score -3.40 SD), with the reduction even more pronounced at level V (spinal Z-score -3.80 SD; hip Z-score -2.30 SD). **Conclusion.** A significantly lower bone mineral density as well as the decreased values of all observed anthropometric parameters, were noted in the children with CP. In the observed sample, bone mineral density in both spine and hip was reduced in all subjects, all of whom also had lower body weight and the BMI, but not body height compared to the existing developmental charts for the children with CP adopted from the US. The children with severe forms of CP (GMFCS-E&R levels IV and V) had significantly lower bone mineral density.

Key words:
cerebral palsy; child; anthropometry; bone density; muscle tonus.

Apstrakt

Uvod/Cilj. Deca sa cerebralnom paralizom (CP) rastu sporije u odnosu na svoje vršnjake. Njihova telesna visina, telesna težina i mineralna koštana gustina značajno su niže u odnosu na opštu populaciju zdrave dece. Cilj ovog rada bio je procena mineralne koštane gustine u odnosu na antropometrijske parametre i nivo grube motoričke funkcije

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kod dece sa CP. **Metode.** Pilot sudija preseka obuhvatila je 23 dece sa CP, uzrasta od 6 do 17 godina, motoričkog nivoa procenjenog prema sistemu klasifikacije grubih motornih funkcija (*The gross motor function classification system-expanded and revised* – GMFCS-E&R) i antropometrijskih parametara prema kartama razvoja za zdravu decu, kao i prema kartama razvoja za decu sa cerebralnom paralizom. Mineralna koštana gustina merena je dvostrukom X-zračnom apsorpciometrijom, a za očitavanje nalaza korišćene su preporuke Internacionalnog udruženja kliničke denzitometrije – *The International Society for Clinical Densitometry Official Positions of Adults & Pediatrics*. Od deskriptivnih statističkih mera korišćena je srednja vrednost sa interkvartilnim odstupanjima, frekvencije i procenti. Razlike između grupa procenjivane su Kruskal-Wallis-ovim testom. **Rezultati.** U uzorku od 23 dece, bilo je 56,5% dečaka i 43,5% devojčica, starosne dobi 13,00 ± 3,56 godina. Njih 4/5 je imalo teži oblik motoričke onesposobljenosti (GMFCS-E&R, nivoi IV i V). Naši ispitanici imali su nižu koštanu gustinu na obe posmatrane regije [Z-skor kičme -1,60 ± 1,40 standardne devijacije (SD); Z-skor kuka -2,00 ± 3,00 SD], kao i niže antropometrijske parametre [Z-skor telesne visine –2,74 ± 4,28; Z-skor telesne mase -3,22 ± 6,96, Z-skor indeksa telesne mase (BMI) -2,64 ± 6,03]. U posmatranom uzorku kod svih ispitanika bila je snižena mineralna koštana gustina na kičmi ($p < 0,01$) i na kuku ($p < 0,05$), a svi su imali nižu telesnu masu ($p < 0,01$) i BMI ($p < 0,01$), ali ne i telesnu visinu u odnosu na postojeće karte razvoja dece sa CP (SAD). Deca sa CP nivo IV GMFCS-E&R imala su značajno manju koštanu gustinu (Z-skor kičme -1,90 SD, Z-skor kuka -3,40 SD), dok kod nivoa V sniženje je bilo još izraženije (Z-skor kičme -3,80 SD, Z-skor kuka -2,30 SD). **Zaključak.** Deca sa CP imala su značajno manju vrednost mineralne koštane gustine kao i svih posmatranih antropometrijskih parametara. U posmatranom uzorku kod svih ispitanika bila je snižena mineralna koštana gustina na kičmi i na kuku, a svi su imali nižu telesnu masu i BMI, ali ne i telesnu visinu u odnosu na postojeće karte razvoja dece sa CP (SAD). Deca sa težim oblicima CP (GMFCS-E&R, nivoi IV i V stepen) imala su značajno manju vrednost mineralne koštane gustine.

Ključne reči:
paraliza, cerebralna; deca; antropometrija; kost, gustina; mišići, tonus.

Introduction

Cerebral palsy (CP) encompasses a group of disorders that, while not progressive, are subjected to frequent change due to the damage to a developing brain [1, 2]. In addition to issues with fine and gross motor functions, communication, and perception and numerous muscle and skeletal difficulties, growth and development of children with cerebral palsy is also compromised [3, 4]. The CP children grow at a slower rate relative to their peers [4]. Their body mass and length as well as bone mineral density are considerably lower than those pertaining to healthy children of comparable age [5–8]. The poorer nutritional status of these children is typically attributed to numerous difficulties in feeding, inadequate calorie intake and variable, often increased, energy requirements [9–11]. The oromotor dysfunction, inadequate chewing and difficulties in swallowing solid, pulpy and/or liquid food are among factors contributing to the stagnation in body weight and length in these children [8, 11]. Growth and development of children with moderate and severe form of cerebral palsy differs from that of their healthy peers. For example, they enter puberty earlier and reach sexual maturity later than healthy children [4, 12]. The assessment of growth and development is facilitated by developmental charts defined by the World Health Organization (WHO) as well as by the Centers for Disease Control and Prevention (CDC). The CDC provides 16 developmental charts (8 per gender) for assessing boys and girls aged 2 to 20. The parameters in these charts are expressed as a percentile and refer to the body height (BH), body weight (BW) and body mass index (BMI) for the children of the same age group [13]. The body mass index is defined as a ratio of body mass and the square of body height expressed in meters (kg/m^2) [14, 15]. Due to the different clinical manifestations of this entity, these charts are not sufficiently precise for use in the assessment and monitoring of children with CP. In recent years, intense efforts have been dedicated to the systematization of the data pertaining to growth and development of CP children in order to formulate nomograms for growth and development of this cohort. BH and BW of children with CP does not meet the reference standards and can therefore not be assessed using the existing developmental charts for healthy children [6, 13–15]. The developmental pattern for children aged under 10 years with the quadriplegic type of CP was developed by Krick et al. [13] based on a sample of 360 children with this condition. The 10th, 50th and 90th percentile for body length (for age group), body weight (for age group) and body weight (for body length) was graphically represented. Day et al. [6] investigated the development of children and adolescents with CP by studying a sample of 24,920 patients, taking into consideration their disability level, gross motor function and the ability to independently eat or be fed via the gastrostomy tube. The authors supplemented their findings by a graphic representation of the development of both genders according to the age [16]. For the assessment of gross motor function in the CP children aged ≤ 18 years, the revised and extended Gross Motor Function Classification System − Expanded & Revised (GMFCS-E&R) is typically used, whereby children are scored on a scale comprising of five levels [17, 18]. The first level on the gross motor function scale is designated for patients who are capable of moving independently, while level V pertains to those that are not able to move independently [18]. For measurements of bone mineral density (BMD), dual energy X-ray absorptiometry (DEXA) is used [19]. When performing the scans, the posterior-anterior (PA) L1-L4 (femoral neck and total hip) are defined as regions of interest (ROI). “Low bone mineral density” is the preferred term for pediatric DXA reports when BMD Z-scores are ≤ 2 standard deviation (SD) [20]. Non-ambulatory children with neurological disorders such as

CP whose muscle tone in all four limbs is increased often have low bone mineral density and are therefore at a greater risk of experiencing fractures [21]. The aim of this research was to evaluate BMD in relation to the anthropometric parameters and the level of gross motor function in the children with CP.

Methods

The sample employed in this pilot prospective study consisted of 23 children with CP aged 6 to 17 years, residing in the "Veternik" Home residential care facility, and the Clinic for Children's Habilitation and Rehabilitation at the Institute for Child and Youth Health Care of Vojvodina, Novi Sad, Serbia. The pilot study was conducted between January 1st and December 31st, 2014. The patients' BMI was calculated based on their body weight (BW) in kg and body height (BH) in m. Using these values, the following parameters were analyzed: BW Z-score (derived from the body weight nomogram, expressed as the Z-score in comparison to the age-equivalent healthy children). The Z-scores for BW, BH and BMI were calculated from nomograms represented as a percentile. TT-p was obtained from the body weight nomograms, expressed as a percentile in comparison to the age-equivalent healthy cohort. The BH Z-score was deduced from the body height nomograms expressed as the Z-score in comparison to the age-equivalent healthy children, BW-p was derived from the body weight nomograms expressed as a percentile in comparison to the age-equivalent healthy cohort. The BMI Z-score was obtained from the BMI nomogram, expressed as the Z-score in comparison to the age-equivalent healthy children, and the BMI-p was obtained from the BMI nomogram expressed as a percentile in comparison to the age-equivalent healthy children. BMI-p was interpreted as follows: below the 5th percentile – malnutrition; from the 5th to the 84th percentile – normal weight; from the 85th to the 94th percentile – excessive body weight; and the 95th percentile and above – obesity [22]. Height for a specific age group, expressed as a percentile, was interpreted as follows: below the 5th percentile – short stature; from the 5th to the 94th percentile – normal height; the 95th percentile and above – tall stature. Weight in relation to that of the peer group, expressed in percentiles, was interpreted as follows: below the 5th percentile – malnutrition; from the 5th to the 84th percentile – normal weight; from the 85th to the 94th percentile – risk of obesity; and the 95th percentile and above – obesity [14, 23]. The body weight and height data was analyzed according to the developmental charts for healthy children issued by the CDC [23] as well as those for children with CP (Growth Charts − Life Expectancy for CP) [24]. Gross motor function for the patients of both genders were classified according to the GMFCS-E&R [18]. All patients were referred for osteodensitometry at the Special Hospital for Rheumatic Diseases, Novi Sad, Serbia. Osteodensitometry was performed using the Lunar device, with the L1-L4 segment and/or the hip serving as ROI. In three of the examined children, DXA failed to provide the adequate spinal data due to the presence of neuromuscular scoliosis, while hips could not be assessed in 12 children owing to flexion contractures associated with the more severe form of CP. The obtained results for BMD (g/cm^2) were interpreted as standard deviations, expressed as the Z-score. In interpreting the BMD results, recommendations from the International Society for Clinical Densitometry, Official Positions Adults & Pediatrics (ISCD) were used [25]. The following parameters were monitored for all patients: gross motor function level according to the GMFCS-E&R scale, BW, BH, and BMI. These values were compared to those pertaining to the age-matched healthy cohort and children with CP and were examined in relation to their BMD presented as the Z-score. The research was carried out with the approval of the Ethics Committee. The clinical data was subjected to the descriptive statistical analyses, whereby the median with interquartile deviations was used, along with frequencies and percentiles. The Kolmogorov-Smirnov and Shapiro-Wilk test results confirmed that the distributions of spine and hip Z-scores were not statistically significantly different from the normal distribution. The between-group differences were determined using the Kruskal-Wallis test. A statistical significance was defined at the zero hypothesis probability level ranging from $p \leq 0.05$ to $p < 0.01$. The statistical processing and analysis was performed using the SPSS (Statistical Package for the Social Sciences) v.20 software.

Results

The pilot study sample comprised 13 boys and 10 girls (56.5% v.s. 43.5%), aged 13.00 ± 3.565 years. According to the CP type, 74% of the patients had quadriparesis and the most severe motor impairment – level V according to the GMFCS-E&R was noted in 69.6% of the sample. The analysis of nomograms for BH, BW and BMI, expressed as the Z-score, revealed that the values pertaining to the study sample were lower than those expected for a healthy cohort. All patients had lower bone mineral density in at least one region of interest. The spine and hip Z-score distributions did not statistically significantly differ from the normal distribution, as indicated by the Kolmogorov-Smirnov test findings and confirmed by the more rigorous Shapiro-Wilk test (Table 1). When assessed using the nomograms for healthy children, more than a half of the children included in our pilot study had short stature (52.2%) and were malnourished relative to their BW (60.9%) and BMI (56.5%). On the other hand, according to the nomograms for the children with CP, 95.7% of our sample had normal BH and normal nutritional status based on the BW (56.5%) and BMI (78.3%) (Table 2). The findings yielded by the Kruskal-Wallis analysis revealed absence of statistically significant differences in the Z-score for hip between the patients with different BH measured in relation to their peers. As all patients for whom the Z-score was measured with the hip serving as ROI were of regular height, it was not possible to calculate the p value. Statistically significant differences ($p < 0.01$) were also noted in the Z-scores measured with the spine used as ROI between the subjects with different BH

and the healthy age-matched cohort. In addition, the Z-score at the spine for the patients with different BW was statistically significantly different at the 0.01 level from that for the age-matched healthy cohort ($\chi^2 = 10.40$; $p = 0.00$) as well as for children with CP ($\chi^2 = 12.27$; $p = 0.00$). A statistically significant difference at the 0.05 level was also noted in the Z-score at the spine between the patients with different BMI in comparison to a healthy age-matched cohort ($\chi^2 = 5.97$; $p = 0.015$) as well as relative to the children with cerebral palsy ($\chi^2 = 9.65$; $p = 0.00$) at the 0.01 level. The Kruskal-Wallis analysis revealed a statistically significant difference at the 0.01 level in the Z-score at the spine ($\chi^2 = 11.33$; $p = 0.00$) and at the 0.05 level in the Z-score at the hip ($\chi^2 = 7.15$; $p = 0.03$) between the patients with different GMFCS (Table 3).

Table 1

Sample characteristics of the study group compared to the healthy cohort

Variables	n	%	Min	Max	Median	IR	Statistic	df	*p*
Gender (total)	23	100.0							
boy	13	56.5							
girl	10	43.5							
Age (years)	23	100.0	6.00	17.00	13.00	3.565			
CP subtypes									
quadriplegia	17	74							
diplegia	3	13							
hemiplegia	3	13							
GMFCS-E&R levels	23	100.0							
I	4	17.391							
IV	3	13.043							
V	16	69.565							
Height Z-score	23	100.0	-6.07	1.66	-2.74	4.28			
Weight Z-score	23	100.0	-20.03	1.47	-3.22	6.96			
BMI Z-score	23	100.0	-22.90	1.83	-2.64	6.03			
BMD spine (g/cm^2)	20	86.956	0.32	1.12	0.558	0.42			
BMD hip (g/cm^2)	11	47.826	0	1	0.6	0			
Z-score spine (SD)	20	86.956	-3.80	1.00	-1.60	1.40			
Kol.-Smir.							0.207	11	0.200
Shap.-Wilk							0.943	11	0.561
Z-score hip (SD)	11	47.826	-4.00	0.00	-2.00	3.00			
Kol.-Smir.							0.154	11	0.200
Shap.-Wilk							0.943	11	0.560

CP – cerebral palsy; GMFCS-E&R – Gross Motor Function Classification System- Expanded & Revised; BMI – body mass index; BMD – bone mineral density; SD – standard deviaton; IR – interquartile range; Kol.-Smir. – Kolmogorov-Smirnov test; Sharp.-Wilk – Shapiro-Wilk test.

Table 2

The body height, body weight and body mass index (BMI) of patients in comparison to the nomograms of healthy children and children with cerebral palsy

Parameters	Nh n (%)	Ncp n (%)
Height Z-score		
short	12 (52.20)	1 (4.30)
normal	10 (43.50)	22 (95.70)
tall	1 (4.30)	
Weight Z-score		
undernourished	14 (60.90)	10 (43.50)
normal	7 (30.40)	13 (56.50)
the risk for obesity	2 (8.70)	
BMI Z-score		
undernourished	13 (56.50)	5 (21.70)
normal	7 (30.40)	18 (78.30)
overweight	2 (8.70)	
obesity	1 (4.30)	
Total	23 (100.00)	23 (100.00)

Nh – characteristics of the sample in relation to the nomograms of healthy children; Ncp – characteristics of the sample in relation to the nomograms of children with cerebral palsy; BMI – body mass index.

Table 3

Bone mineral density in comparison to the anthropometric parameters and the level of gross motor function in the patients with cerebral palsy according to the nomograms of healthy children and children with cerebral palsy

Parameters	Z-score lumbar spine		Z-score hip	
	Nh	Ncp	Nh	Ncp
Height				
short	-3.80	-4.20	-2.60	/
normal	-1.70	-1.90	-1.70	-2.00
tall	-0.70	/	-0.50	/
χ^2	9.99	1.70	2.05	/
p value	0.01†	0.19	0.36	/
Weight				
underweight	-3.80	-4.10	-3.00	-3.40
healthy weight	-1.60	-1.60	-2.00	-1.85
at risk of overweight	-0.40	/	-0.20	/
χ^2	10.40	13.27	1.08	1.24
p value	0.00†	0.00†	0.30	0.27
BMI				
underweight	-3.95	-4.20	-3.40	-3.40
healthy weight	-1.80	-1.90	-2.00	-1.85
overweight	-0.40	/	-0.20	/
obesity	-1.90	/	-2.00	/
χ^2	5.97	9.65	0.36	1.24
p value	0.01†	0.00†	0.54	0.27
GMFCS-E&R levels				
I		0.30		-0.40
IV		-1.90		-3.40
V		-3.80		-2.30
χ^2		11.33		7.15
p value		0.00†		0.03*

Nh – characteristics of the sample in relation to the nomograms of healthy children; Ncp – characteristics of the sample in relation to nomograms of children with cerebral palsy; BMI – body mass index; GMFCS-E&R – Gross Motor Function Classification System Expanded & Revised.
***p* < 0.05; †*p* < 0.01.**

Discussion

The children with CP, especially those with the most frequent spastic type, are less physically active than their healthy peers. Along with the mobility difficulties, deviations in growth and development are often noted in this cohort. Monitoring the growth and development is of the utmost importance in ensuring optimal child health. The assessment of these parameters is simplified by the use of nomograms developed by the WHO and other institutions. As the growth and nutritional status assessments aimed at the children with cerebral palsy are not standardized, this represents a real challenge for medical practitioners [26]. The children with CP living both in developed and undeveloped countries have lower BH and BW in comparison to their healthy peers, as indicated by numerous studies and observed in this research [5, 24]. In our pilot study, 19 of 23 subjects had the most severe type of gross motor disability (GMFCS-E & R levels IV and V), while the most frequent type of CP was quadriparesis (the bilateral spastic type). All subjects had lower BH, nutritional status and BMD relative to that measured in their healthy peers. In our pilot study, the DXA scanning could not be performed at lumbar spine in three patients due to the presence of neuromuscular scoliosis, while DXA of either hip was unfeasible for 12 patients because of flexion contracture of the hip. Indeed, the difficulties associated with performing the DXA scans were some of the obstacles, in terms of technical feasibility in assessing the bone health of children with CP. Conditions such as hip contractures and hip dysplasia, scoliosis and metal implants often prohibit the DXA measurements at the desired region of interest (lumbar spine or proximal femur) [26, 27]. "Low bone mineral density" is the preferred term for the pediatric DXA reports when the BMD Z-scores are ≤ 2 SD [20]. As mineral density is often low in the children with CP, they are at a risk of fractures at a minimal trauma, which additionally compromises their quality of life [28]. Our results showed that more than a half of the subjects included in our sample had shorter stature and were malnourished according to the body weight and BMI nomograms pertaining to their healthy peers. In comparison to the age-equivalent cohort with cerebral palsy, a majority of the subjects had normal body height and were well nourished according to the BMI, while approximately the same number of children were in the malnourished and well-nourished group. Malnutrition is a frequent problem in the CP children, resulting in the lower muscle strength and poor immunological status [29]. In the study conducted by Karagiozoglou-Lampoudi et al. [15], the anthropometric data for 42 CP patients aged 8.0 ± 4.0 years was analyzed using the Z-scores given by the WHO. Subjects were divided into three groups (comprising 10, 8 and 24 children, respectively), based on

the level of gross motor function according to the GMFCS-E&R: mild (GMFCS-E&R levels I and II), moderate (GMFCS-E&R levels III) and severe (GMFCS-E&R Level IV and V). Thus, a majority of the subjects had either poor mobility or were immobile. When the nutritional status of the sample was assessed in terms of the Z-score according to the WHO, 38.1% of the patients were malnourished while 7.1% were over-nourished. In this study, the Z-scores provided by the WHO was a useful instrument for monitoring the level of nourishment in the CP children [15]. In the study conducted by Dahlseng et al. [9], data from a Norwegian registry of cerebral palsy was analyzed. According to the results reported by the authors, 21% of the children whose data was included in the evaluation were completely dependent on others for help with feeding, while 14% of the sample was fed using the gastrostomy tube. Even though prolonged gastrostomy feeding is connected to the higher body mass and BMI, but not to increased BH, one in four children included in the aforementioned study was malnourished. In our pilot study, our aim was to ascertain whether there were statistically significant differences in the Z-scores pertaining to the hip and spine among subjects with the different body height, body weight and BMI. Extant literature indicates that children of short stature do have lower BMD measured at the lumbar spine in comparison to the CDC nomograms for healthy children [14]. When BW was analyzed in relation to the BMI, the group of underweight children was found to have lower BMI at the lumbar spine in comparison to the CDC nomograms for the healthy age-equivalent cohort, as well as relative to the developmental charts for the children with CP. Children with more severe motor impairment had lower bone mineral density both at the lumbar spine and the hip. Wren et al. [30] used quantitative computed tomography to assess bone density in 37 children with CP and compared their findings with those pertaining to their healthy peers. The children with CP had lower bone density measured at the tibia, while volumetric bone density decreased with the rise of the GMFCS level [30]. Nevertheless, the clinical importance of abnormal DXA findings and its correlation to an increased risk of fracture is still unclear. A careful assessment is necessary, with a close monitoring of patients at a greater bone demineralization risk [31]. Due to the significantly decreased bone mineral density, the children with CP often suffer from the painful fractures following even minimal trauma, and this fragility considerably affects their day-to-day functioning and quality of life. If a child is at a risk, it is necessary to repeat the osteodensitometric measurements at 1−2 year intervals, depending on the clinical findings and existing risk factors specific to the child [28]. Our investigation revealed a highly statistically significant difference in the Z-score for the spine ($p < 0.01$) and the hip ($p < 0.05$) between subjects classified at different GMFCS-E&R levels. More specifically, children with more severe motor disability (GMFCS-E&R level V) had a considerably lower Z-score measured at the spine in comparison to children who were ambulatory without limitations (GMFCS-E&R level I). The ambulatory children with CP classified at GMFCS-E&R Level I had a higher BMD at the hip in comparison to the CP children with more severe motor disability (GMFCS-E&R levels IV and V). By analyzing the nutritional status of the children included in our study sample, and comparing the findings with the growth charts for the children with CP in the US [16], we obtained similar results. Since, in Serbia, no developmental charts for the CP children presently exist, we utilized the Growth Charts-Life Expectancy for the CP chart 24 in our analyses. The growth patterns for the children with CP differ significantly from those observed in the general population and exhibit a considerable deviation according to the severity of functional damage based on GMFCS [32]. The study conducted in Turkey by Şimşek and Tuç [33] marked the first attempt to investigate the connection among the BMI, functional independence and quality of life in children with cerebral palsy. The authors concluded that lower BMD may decrease the everyday activity level as well as compromise quality of life of the children with CP. In an earlier study, Henderson et al. [34] analyzed the data pertaining to 117 children aged 2 to 19 years, all of whom had a moderate or severe CP type according to the GMFCS. The BMD value expressed as the Z-score was lower at the distal femur relative to that measured at the lumbar spine. The lower BMI values were found in children with more severe CP types in comparison to those with the moderate type.

The key limitations in our pilot study stem from the small, heterogenic sample investigated, which did not include the children with levels II and III gross motor function abilities, as well as a small number of children rated at level I (according to the GMFCS-E&R scale). Moreover, other possible risk factors, such as the type and number of anti-epileptic drugs and long-term effects of these medications, a lack of exposure to sunlight (which can cause vitamin D deficiency), nutritive limitations, etc., were not considered in the analyses.

Conclusion

In our pilot study, a much lower bone mineral density, as well as the values of other assessed anthropometric parameters, were recorded for children with CP. In all subjects included in the study sample, the spine and hip BMD was reduced, as was their BW and BMI, but not BH, relative to the available development scales for the CP children used in the US. Inadequate nutritional support for children with CP (especially those with more severe CP forms) was likely to contribute to the lower body weight and BMI values recorded in this study when compared to the utilized nomograms. The children with the more severe CP forms (GMFCS-E&R levels IV and V) had a statistically significantly lower BMD.

The findings yielded by our study indicate regular evaluation of children with CP, their BW, BH, BMI and BMD. We further suggest to invest greater efforts into the understanding and application of various preventive measures aimed at maintaining BMD (nutritive support, vitamin supplementation, kinesitherapy, etc.).

A multidisciplinary approach to the evaluation of children with CP, as well as a set of recommendations and good clinical practice for those populations are clearly needed.

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